

Wind Energy Update



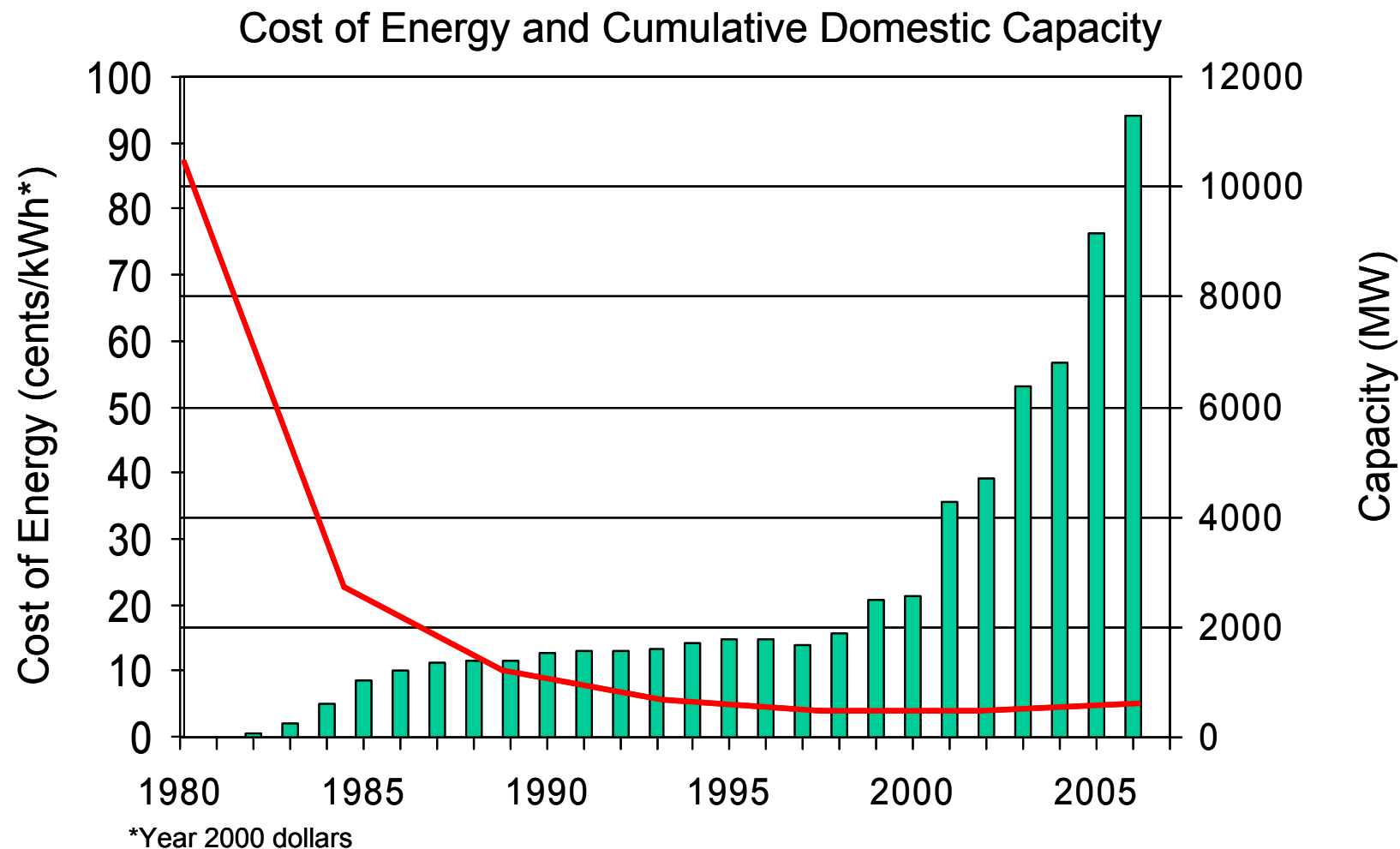
Larry Flowers

National Renewable Energy Laboratory

November 30, 2007

Salt Lake City, UT

Capacity & Cost Trends



Increased Turbine Size - R&D Advances - Manufacturing Improvements

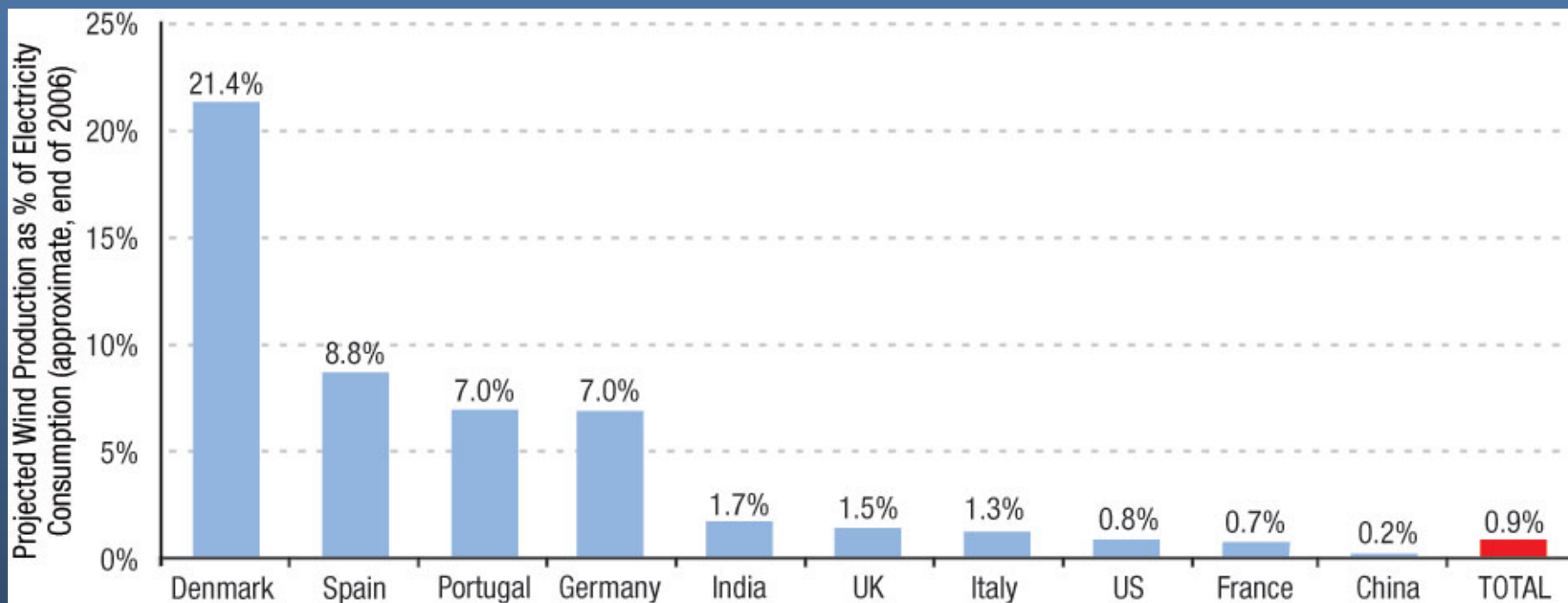
U.S. Leads World in Annual Wind Capacity Additions; Third in Cumulative Capacity

Table 1. International Rankings of Wind Power Capacity

Cumulative Capacity (end of 2006, MW)		Incremental Capacity (2006, MW)	
Germany	20,652	US	2,454
Spain	11,614	Germany	2,233
US	11,575	India	1,840
India	6,228	Spain	1,587
Denmark	3,101	China	1,334
China	2,588	France	810
Italy	2,118	Canada	776
UK	1,967	UK	631
Portugal	1,716	Portugal	629
France	1,585	Italy	417
Rest of World	11,102	Rest of World	2,305
TOTAL	74,246	TOTAL	15,016

Source: BTM, 2007; AWEA/GEC dataset for U.S. cumulative capacity.

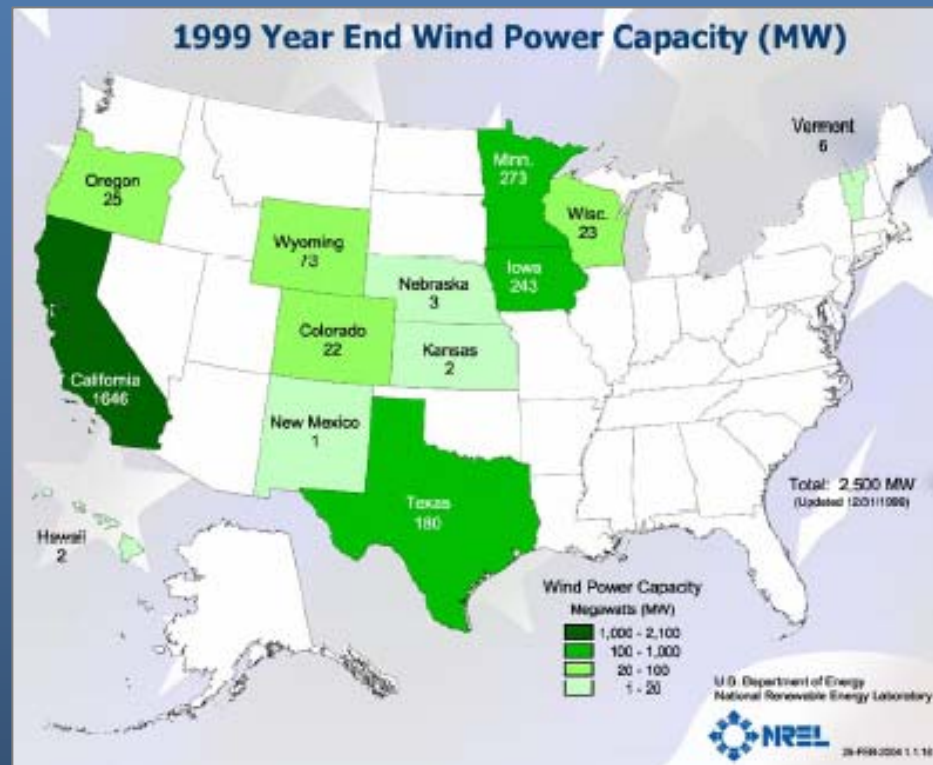
U.S Lagging Other Countries for Wind As a Percentage of Electricity Consumption



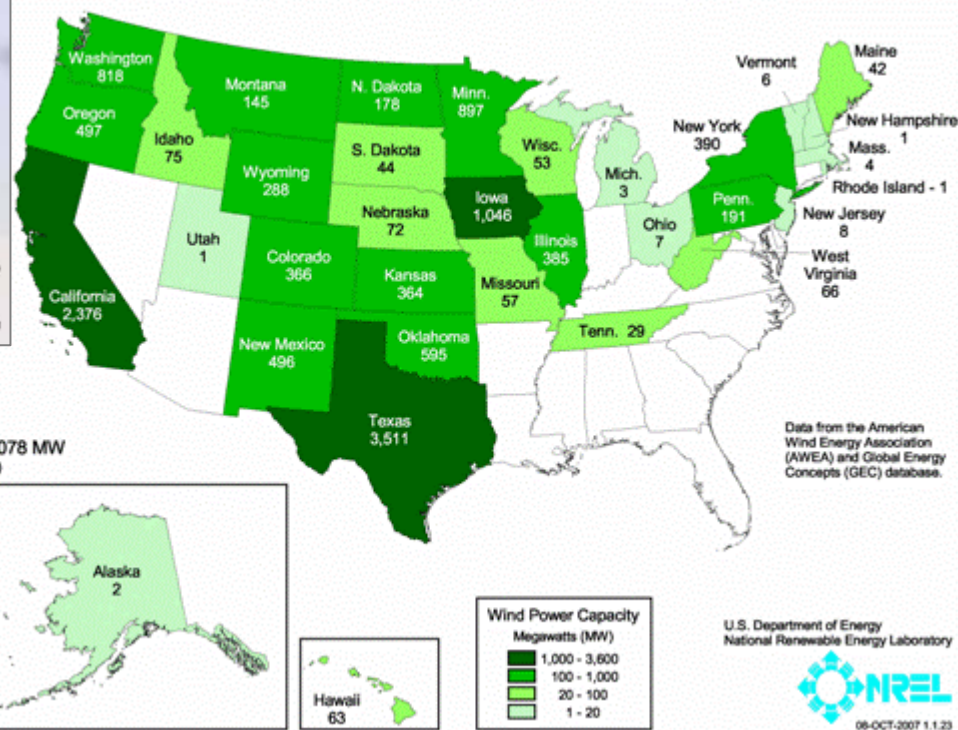
Source: Berkeley Lab estimates based on data from BTM and elsewhere.

Installed Wind Capacities (‘99 – Sept 07)

1999 Year End Wind Power Capacity (MW)



United States - Current Installed Wind Power Capacity (MW)

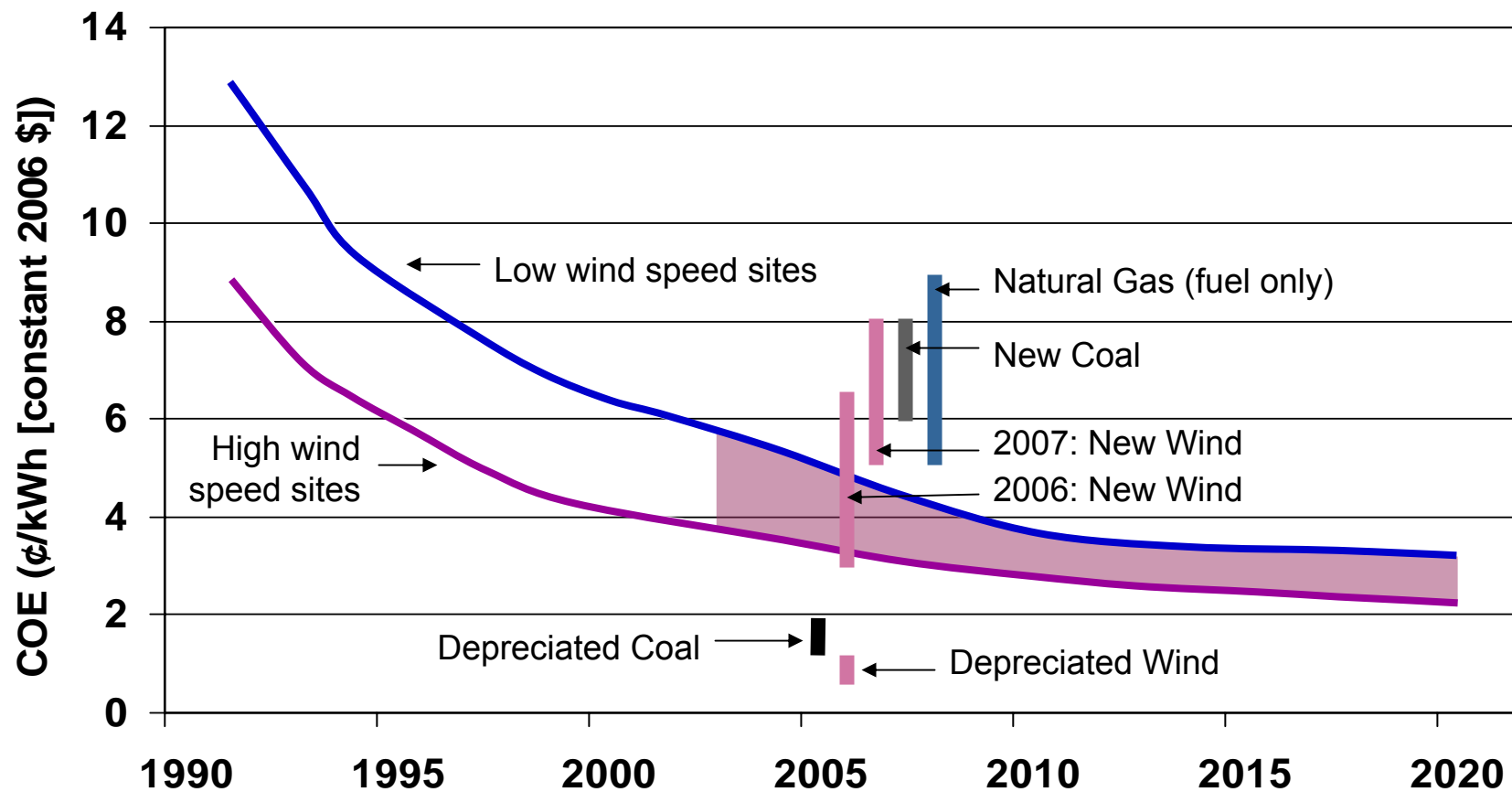


Drivers for Wind Power

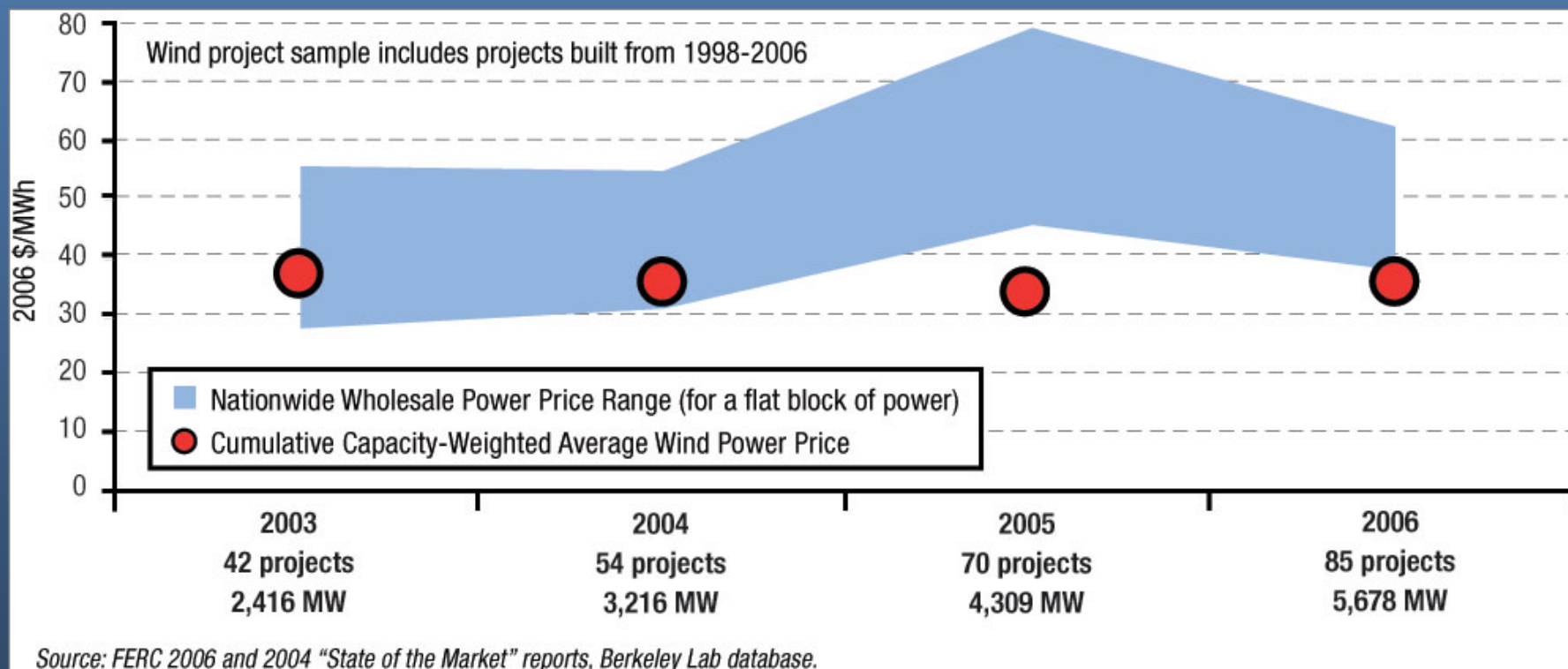
- Declining Wind Costs
- Fuel Price Uncertainty
- Federal and State Policies
- Economic Development
- Public Support
- Green Power
- Energy Security
- Carbon Risk



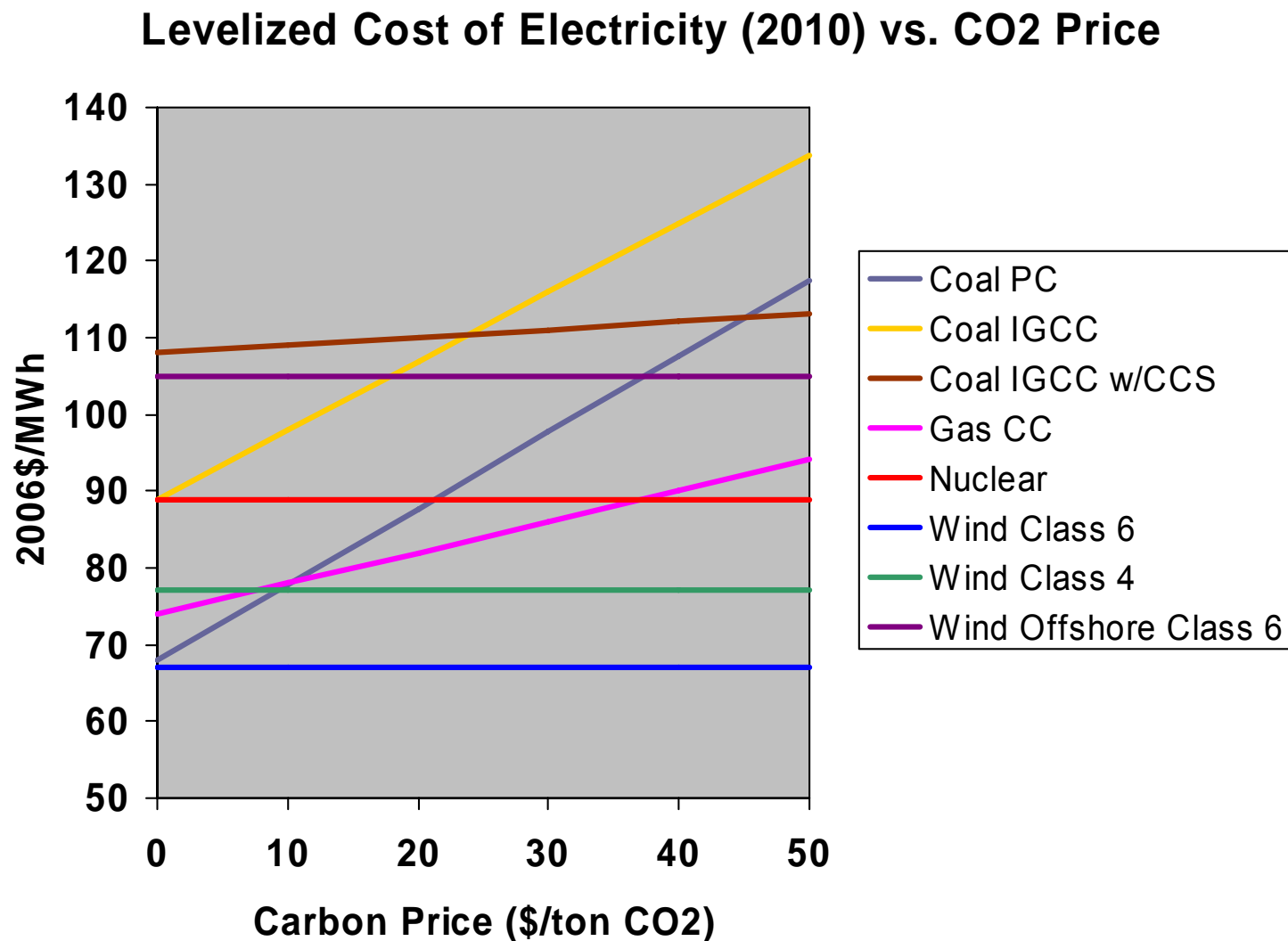
Wind Cost of Energy



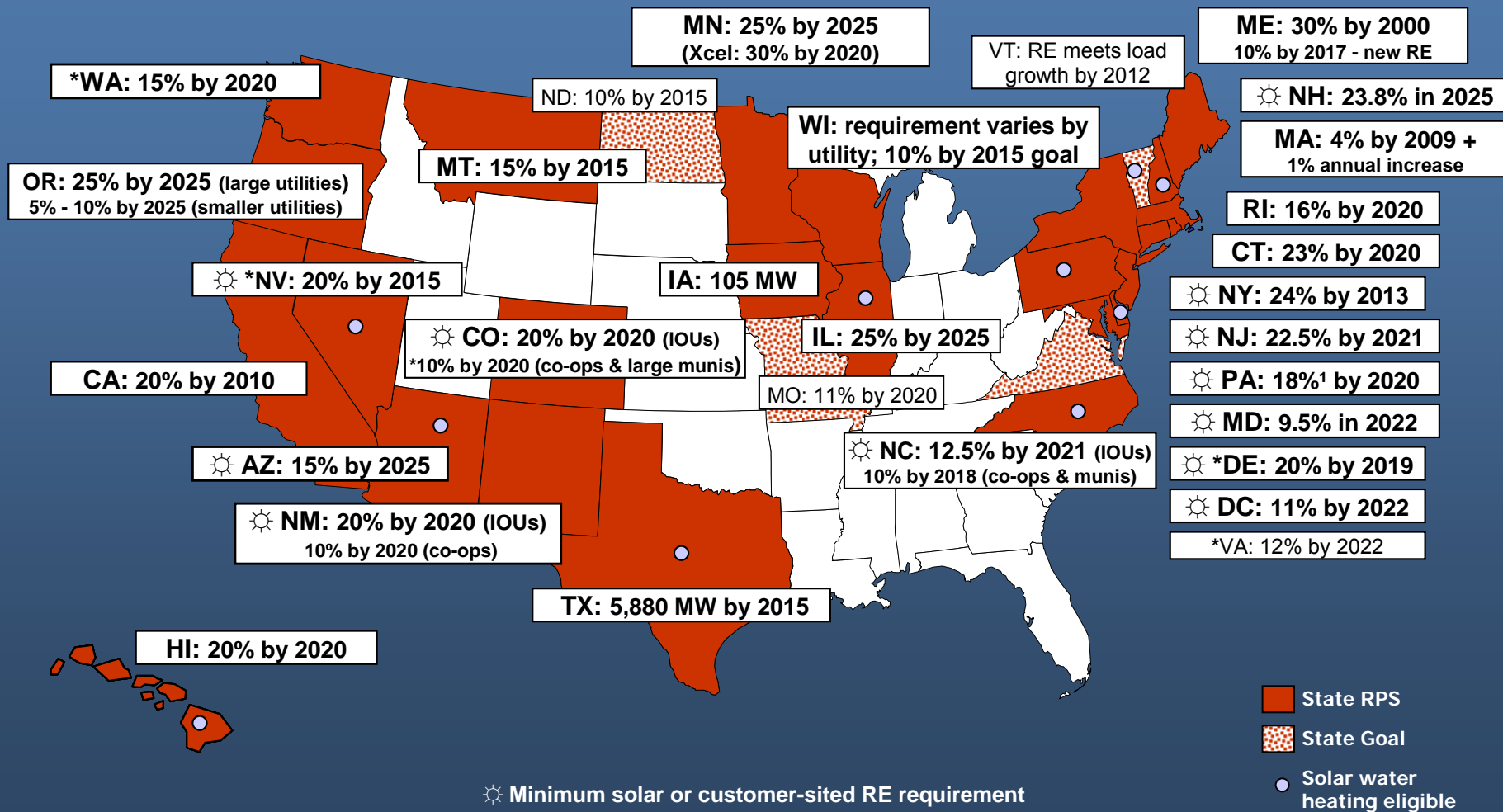
Nationally, Wind Has Been Competitive with Wholesale Power Prices in Recent Years



CO₂ prices significantly increase the cost of coal



Renewables Portfolio Standards



Wind Energy Investors



SIEMENS



BP Solar



JOHN DEERE



Economic Development Impacts

- **Land Lease Payments:** 2-3% of gross revenue \$2500-4000/MW/year
- **Local property tax** revenue: ranges widely - \$300K-1700K/yr per 100MW
- 100-200 **jobs**/100MW during construction
- 6-10 permanent O&M **jobs** per 100 MW
- Local construction and service industry: concrete, towers usually done locally



Case Study: Texas



Utilities and wind companies invested \$1B in 2001 to build 912 MW of new wind power, resulting in:

- **2,500 quality jobs with a payroll of \$75M**
- \$13.3M in tax revenues for schools and counties
- \$2.5M in 2002 royalty income to landowners
- Another 2,900 indirect jobs as a result of the multiplier effect
- \$4.6M increase in Pecos County property tax revenue in 2002

Case Study: New Mexico

- 204-MW wind project built in 2003 in DeBaca and Quay counties for PNM
- 150 construction jobs
- 12 permanent jobs and \$550,000/yr in salaries for operation and maintenance
- \$550,000/year in lease payments to landowners
- **\$450,000/year in payments in lieu of taxes to county and school districts**
- Over \$40M in economic benefits for area over 25 years



Photo: PNM

Case Study: Prowers County, Colorado



- 162-MW Colorado Green Wind Farm (108 turbines)
- \$200M+ investment
- 400 construction workers
- 14-20 full-time jobs
- Land lease payments \$3000-\$6000 per turbine
- **Prowers County 2002 assessed value \$94M; 2004 assessed value +33% (+\$32M)**
- **Local district will receive 12 mil tax reduction**
- Piggyback model

“Converting the wind into a much-needed commodity while providing good jobs, the Colorado Green Wind Farm is a boost to our local economy and tax base.”

John Stulp, county commissioner, Prowers County, Colorado

Local Ownership Models

- Minnesota farmer cooperative (Minwind)
- FLIP structure
- Farmer-owned small wind
- Farmer-owned commercial-scale



© L. Kennedy

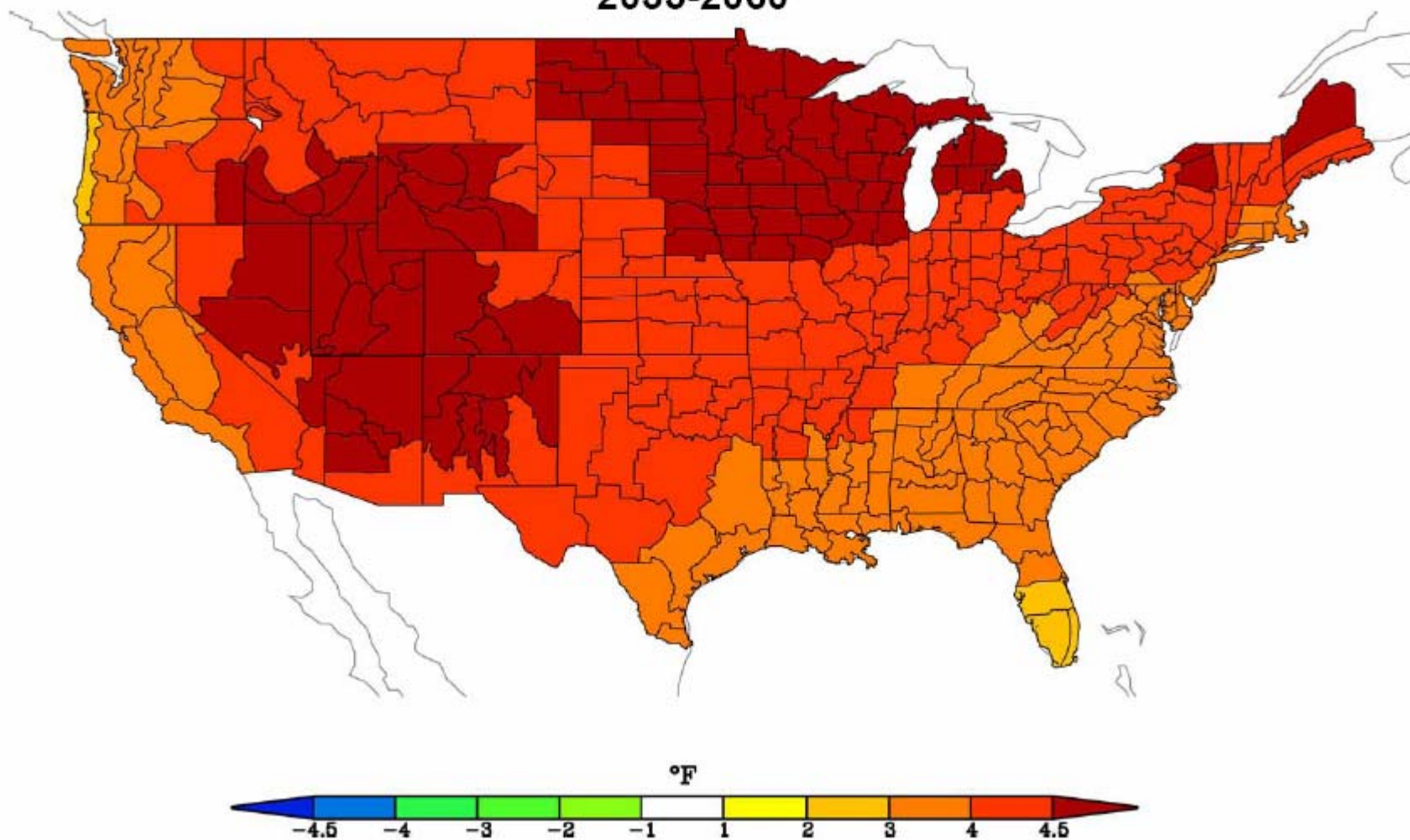


Environmental Benefits

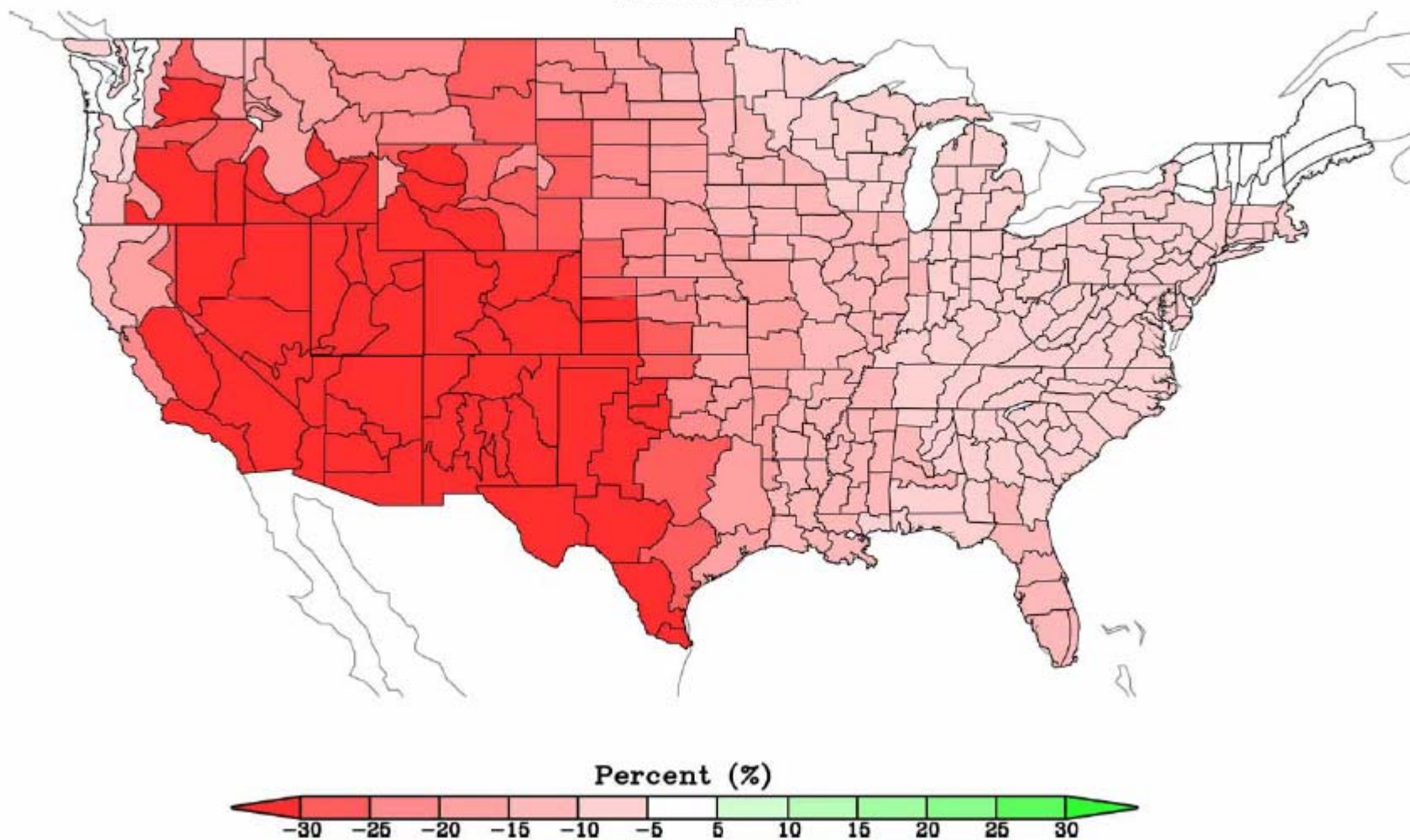
- No SO_x or NO_x
- No particulates
- No mercury
- No CO₂
- No water



Change in Annual Temperature 2035-2060



Change in Annual (PCPN-Potential Evapotranspiration) 2035-2060



Energy-Water Nexus

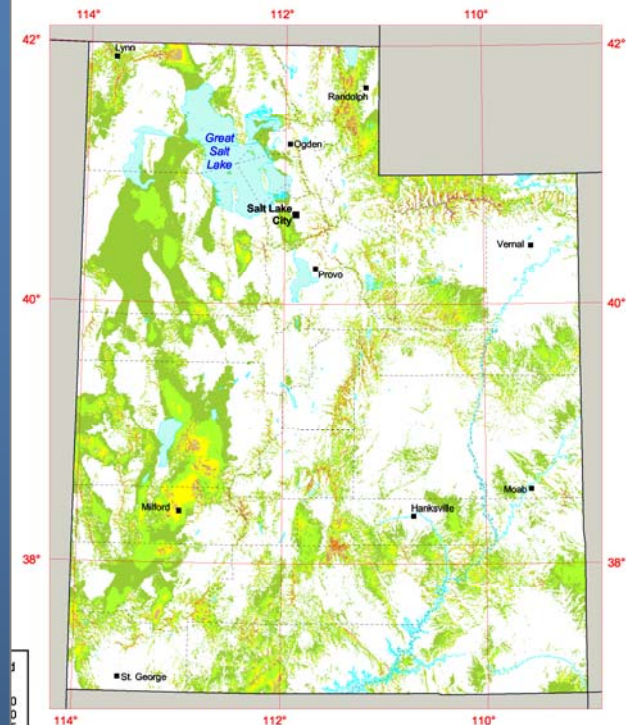


Key Issues for Wind Power



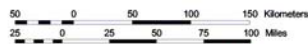
- Policy Uncertainty
- Siting and Permitting: avian, noise, visual, federal land
- Transmission: FERC rules, access, new lines
- Operational impacts: intermittency, ancillary services, allocation of costs
- Accounting for non-monetary value: green power, no fuel price risk, reduced emissions

Utah - 50 m Wind Speed



Not Validated

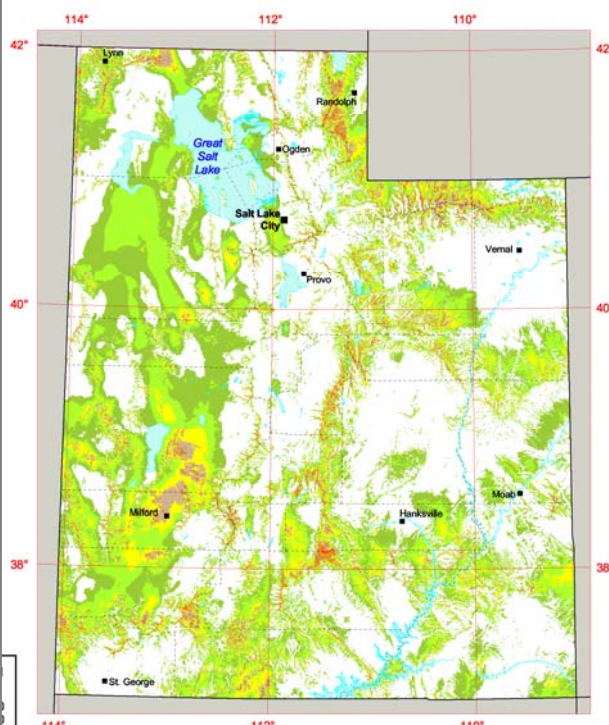
The data for this map was produced by AWS TrueWind using the Mesomap system and historical weather data.



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Utah - 70 m Wind Speed



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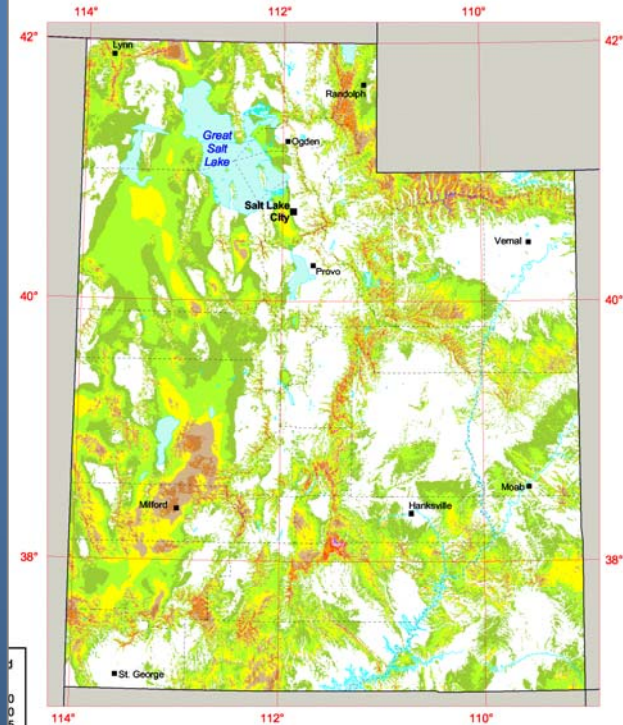
The data for this map was produced by AWS TrueWind using the Mesomap system and historical weather data.



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Utah - 100 m Wind Speed

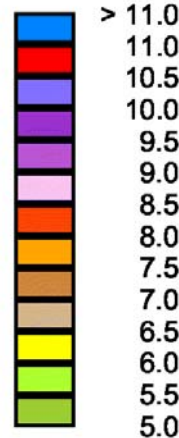


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Wind Speed
m/s



A New Vision *For Wind Energy in the U.S.*



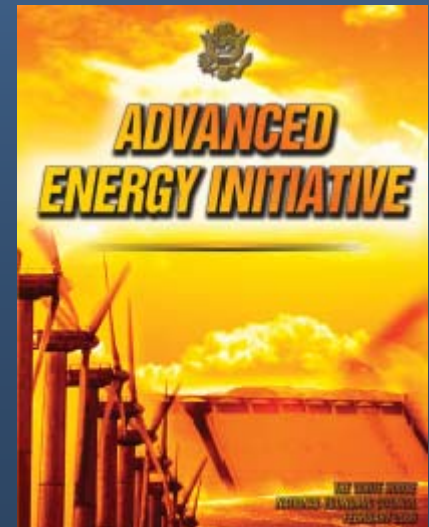
White House photo by Eric Draper

State of the Union Address

“...We will invest more in ...
revolutionary and...**wind technologies**”

Advanced Energy Initiative

“Areas with good wind resources have the potential to **supply up to 20% of the electricity** consumption of the United States.”



20% Wind-Electricity Vision

*Wind energy will provide **20% of U.S. electricity needs by 2030**, securing America's leadership in reliable, clean energy technology. As an inexhaustible and affordable domestic resource, wind strengthens our energy security, improves the quality of the air we breathe, slows climate change, and revitalizes rural communities.*

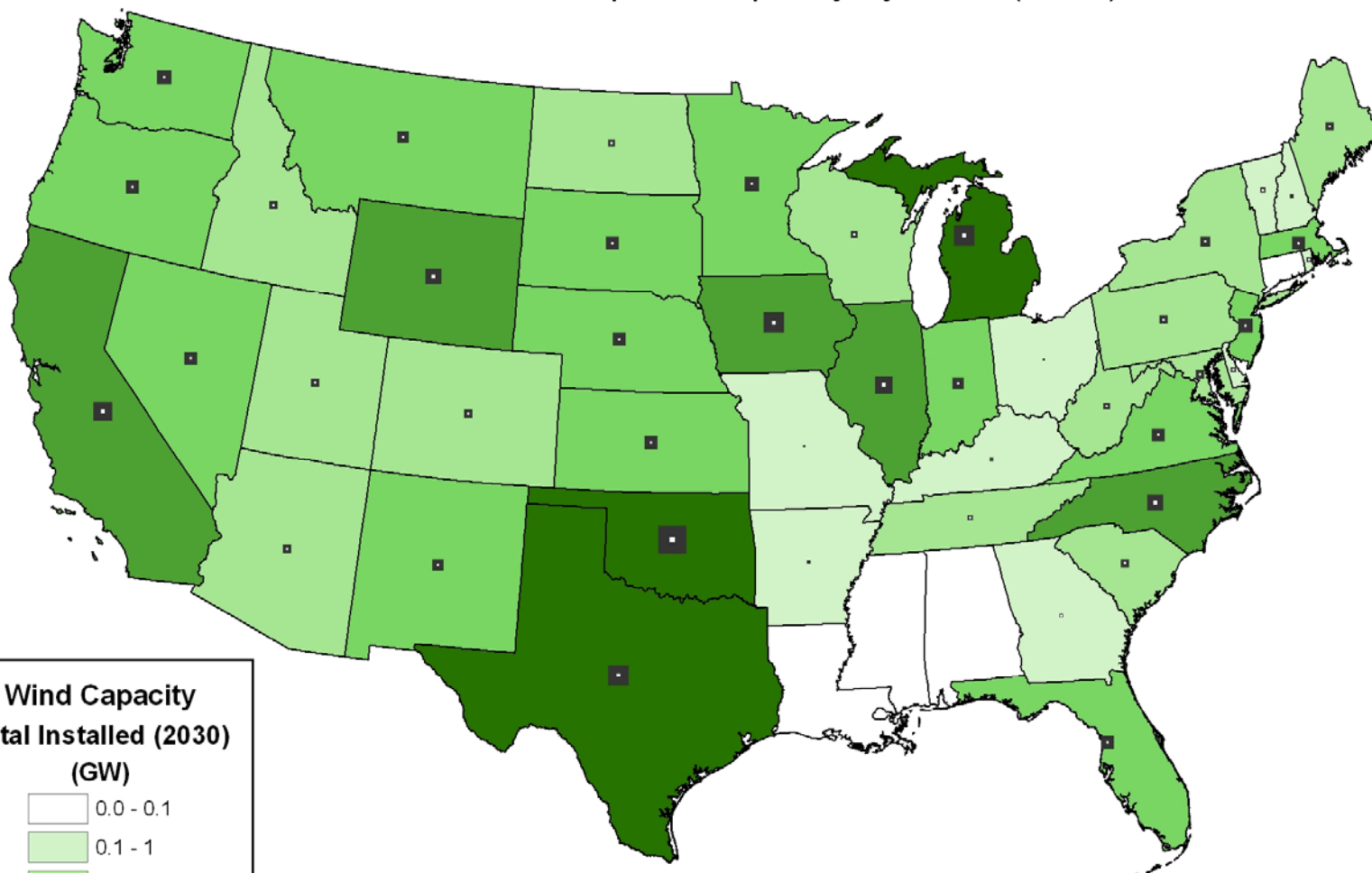
awea

american wind
energy association

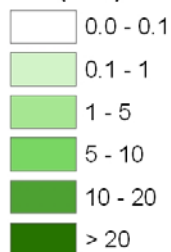


www.awea.org

Installed Wind Nameplate Capacity by State (2030)

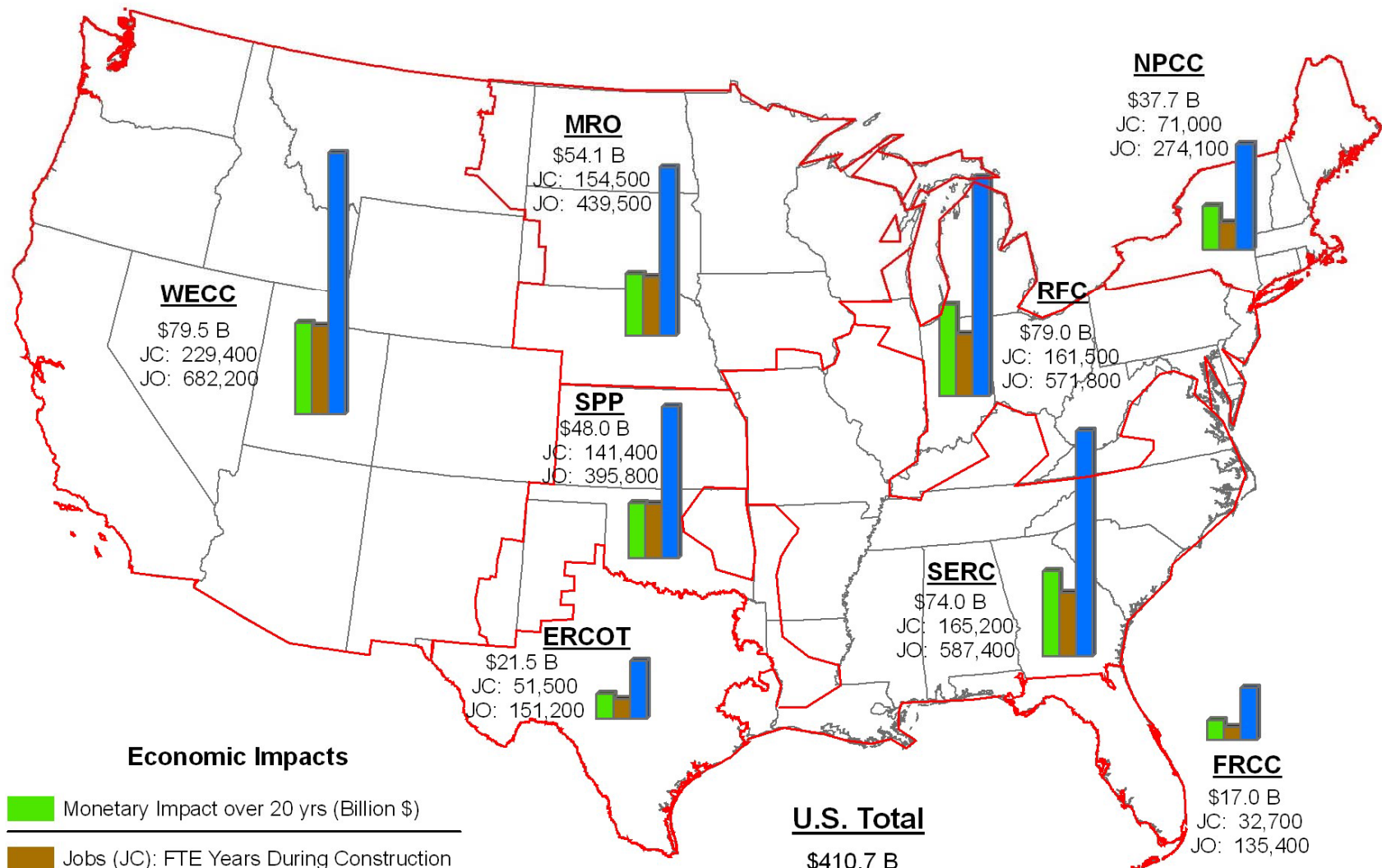


Wind Capacity Total Installed (2030) (GW)



The black square in the center of a state represents the land area needed for a single wind farm to produce the projected installed capacity in that state. The white square represents the actual land area that would be dedicated to the wind turbines (2% of the black square).

20% Wind Electricity by 2030 - Economic Impacts by NERC Region



Economic Impacts

- Monetary Impact over 20 yrs (Billion \$)
- Jobs (JC): FTE Years During Construction
- Jobs (JO): FTE Years over 20 yrs Operation

Wind Vision case = 304 GW of wind capacity.
All job values rounded to the nearest 100.

U.S. Department of Energy
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Utah – Economic Impacts

From the 20% Vision

(2,449 MW new Utah development)

Wind energy's economic "ripple effect"

Direct Impacts

Payments to Landowners:

- \$6.53 million/year

Local Property Tax Revenue:

- \$27.24 million/year

Construction Phase:

- 3,883 new jobs
- \$461.8 M to local economies

Operational Phase:

- 616 new long-term jobs
- \$52.0 M/yr to local economies



Indirect & Induced Impacts

Construction Phase:

- 3,292 new jobs
- \$292.2 M to local economies

Operational Phase:

- 497 local jobs
- \$46.1 M/yr to local economies

Totals

(construction + 20yrs)

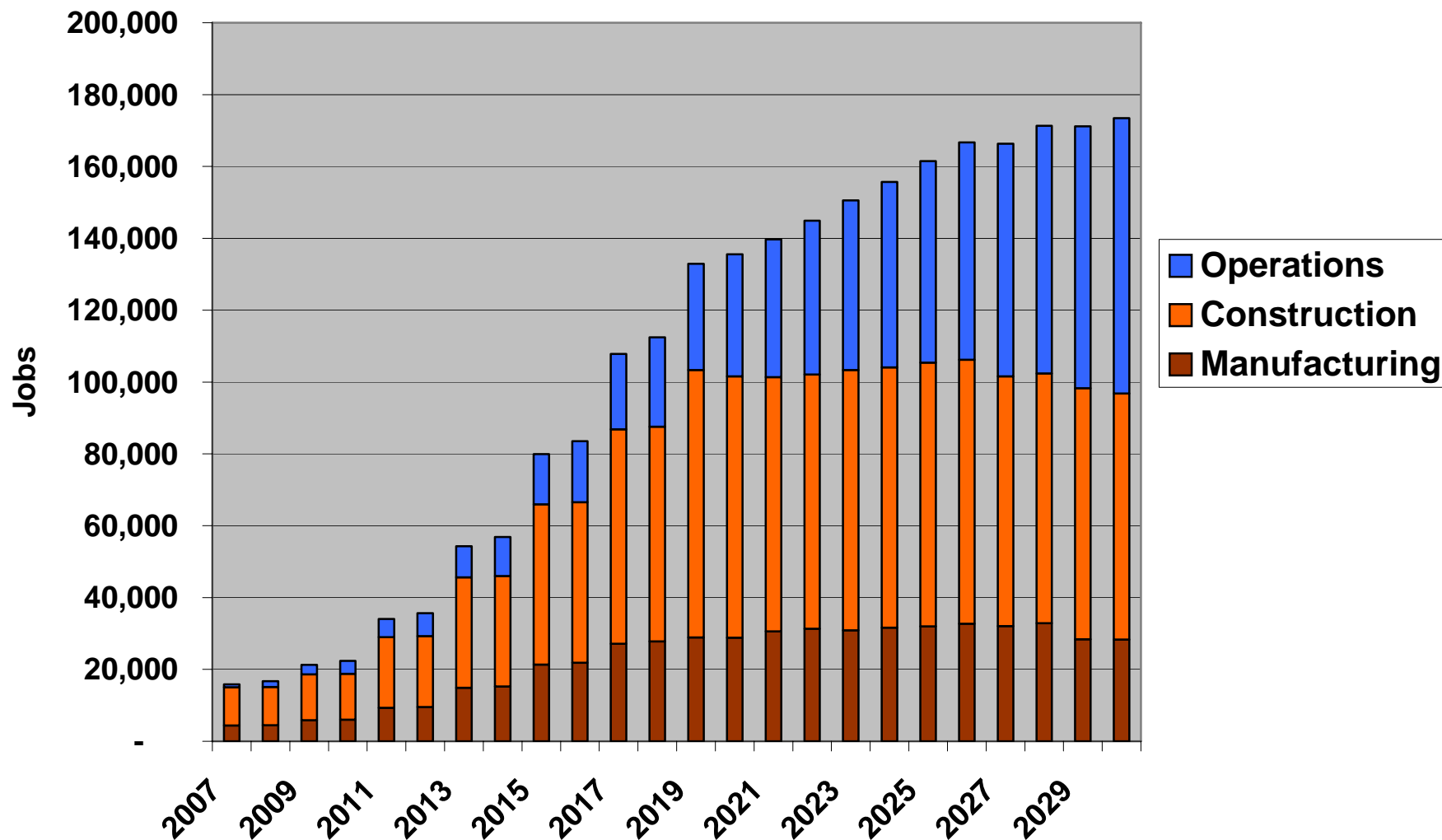
Total economic benefit
= \$2.72 billion

New local jobs during construction = 7,175

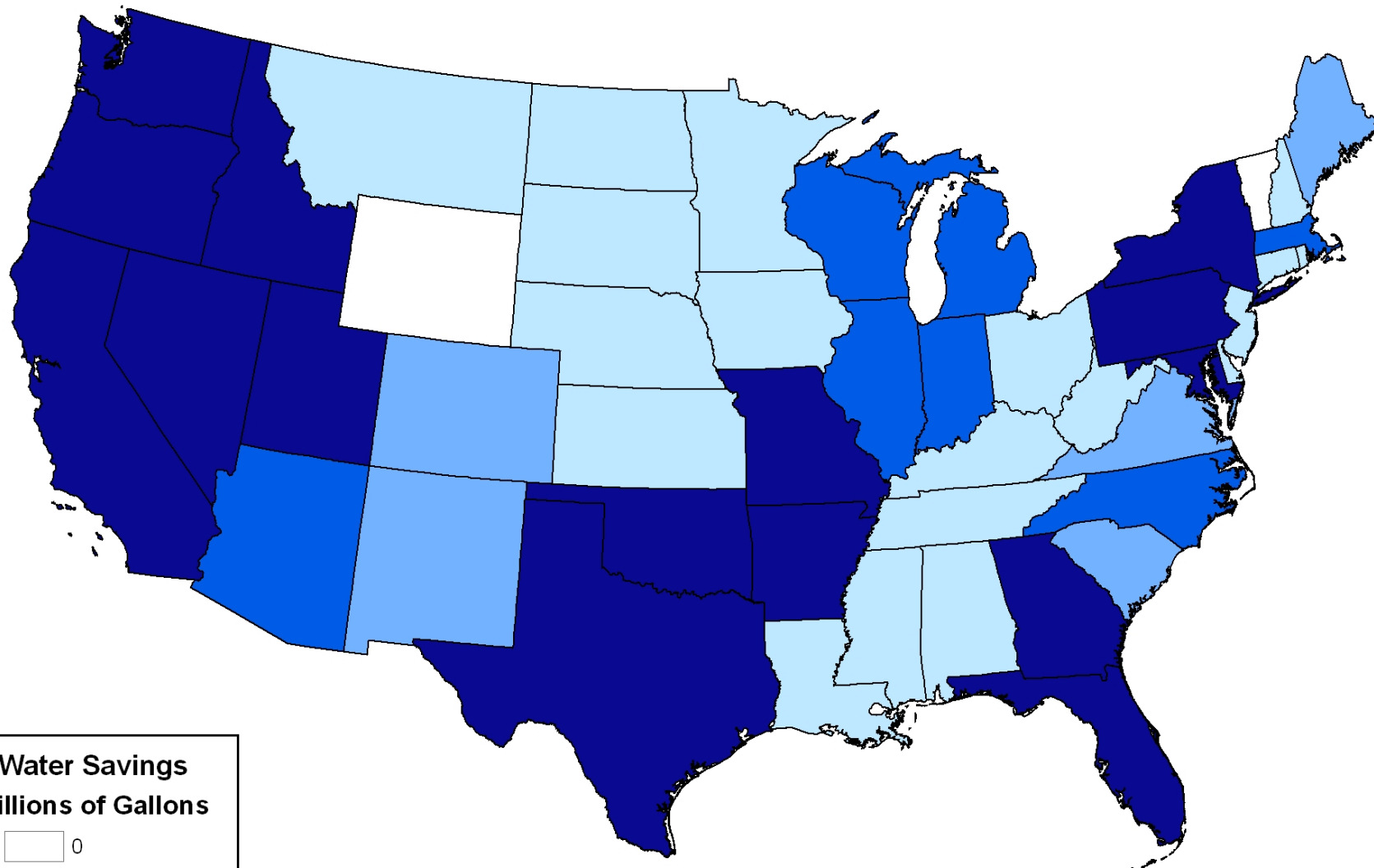
New local long-term jobs = 1,113

Construction Phase = 1-2 years
Operational Phase = 20+ years

20% Wind Vision Employment



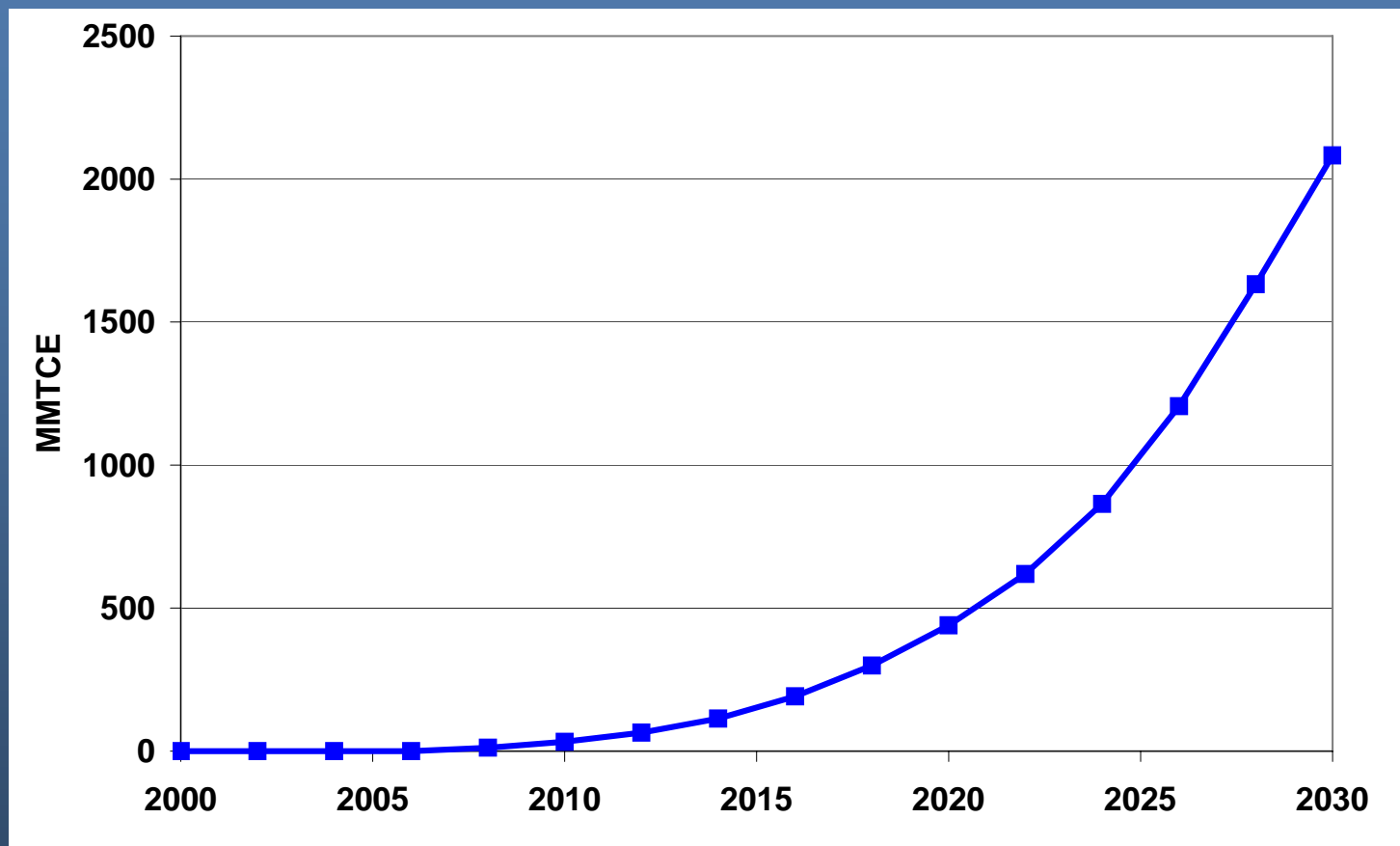
Cumulative Water Savings Due to Deployment of Wind Energy (2008 - 2030)



Water Savings Billions of Gallons

0
0.01 - 25
25 - 50
50 - 100
> 100

Cumulative Carbon Savings



Cumulative Carbon Savings (2007-2050, MMTCE)	Present Value Benefits (billion 2006\$)	Levelized Benefit of Wind (\$/MWh-wind)
4,182 MMTCE	\$ 50 - \$145	\$ 9.7/MWh - \$ 28.2/MWh

Results: **Costs** & **Benefits**

Incremental direct cost to society	\$43 billion
Reductions in emissions of greenhouse gasses and other atmospheric pollutants	825 M tons (2030) \$98 billion
Reductions in water consumption	8% total electric 17% in 2030
Jobs created and other economic benefits	140,000 direct \$450 billion total
Reductions in natural gas use and price pressure	11% \$150 billion
Net Benefits: \$205B + Water savings	

Carpe Ventem

